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Claim Reserving Estimation by Using the Chain Ladder Method

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Abstract

An insurance company promises its policyholders to pay out benefits if certain events occur, for example, events such as a car accident and health conditions. When this is happens, the insurance company has a liability to pay the claim by claim reserving. The calculation of claim reserving must be done carefully in such a way that it should not cause loss to the company. One of the simplest methods to calculate claim reserving is the chain ladder method (CL). The method uses an algorithm that can be used to estimate claim reserving in the future. The CL method estimates the claim reserving to be paid by using run-off triangle data. The rows on a run-off triangle data represent claim occurrence periods and the columns represent development periods, the periods when claim were settled. The real data used is a claim amount observed in the past that is located in the upper-left triangle, and the lower triangle has to be estimated. This research will use the data from one of the insurance companies in Indonesia taken from OJK.

Keywords: claim, CL method, run-off triangle, claim reserving

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1. Introduction

In Indonesia, there are legally two types of the insurance industries, life insurance and general insurance. Life insurance is an insurance that pays out a sum of money either on the death of the insured person or after a set period. General insurance or non-life insurance policies, including automobile and homeowners policies, provide payments depending on the loss from a particular financial event. General insurance is typically defined as any insurance that is not determined to be life insurance.

Policy period on life insurance usually long term basis, depend on how old the insured is. In general insurance, policy period usually short term basis. It can be a year on automobile insurance, or more on another type of insurance. After a policy contract ended, the policy can be renewed or canceled. If a policy canceled, the insurer or the insurance company still has a liability to pay out all benefit to the insured. Meanwhile,

the insurer also has a liability to pay out all the claims if certain events occur. Such events for example:

- A car accident where the policyholder is at fault and a third party's car is damaged (motor vehicle liability insurance)
- A fire occurs in a policyholder causing damage to the kitchen (fire insurance)

A claim event is an event that gives rise to a claim issued by an insured. Because of the unpredictability of these events, insurer can be suddenly face the possibility of paying claims as the policy dictates and in some cases it can be very large.

To make sure all the claims paid, the insurer must have enough reserves. An insurance company must set aside enough money to pay all claims, present and future, on the policies currently in force. Inadequate reserves can lead to insolvency and over-adequate reserves can lead to premium rates that are not competitive. That money we call it as a claim reserve.

The claim reserve is used to pay out claim that have been reported and are qualified to be paid. The claim payment can be directly paid after reported or sometimes need more time to be paid so there are some delay times come up. The relationship between the occurrence and the associated delays this claim referred to the outstanding claim. There are two types of outstanding claims, Incurred but Not Reported (IBNR) and Reported but Not Settled (RBNS). IBNR is an occurrence that already happened but has not yet reported. On the other side, RBNS is an occurrence that already reported but all the payments come up have not settled yet.

IBNR claims reserve calculations are generally more difficult than RBNS because in some instances many policyholders are unaware of whether he should file a claim or not. For instance on the case when an accident happened, the policyholder makes a claim few week after the impact felt. The result will be a time delay between the date of the incident and the date on which the claim was reported to the insured. Similarly happens at the time of payment of claims. While the process is not short, there could be a claim payment is done several times until finally settled. It also happens to delay the reporting date and time period in which the claim was declared finished.

The method is often used to estimate claims reserves are chain ladder method (CL). The chain-ladder method is simple and logical, and is widely used in general insurance. This method uses an algorithm that can be used to estimate claims reserves in the future (Mack 1994). The CL method is a distribution-free method [5] relieving some of the usual assumptions common to most modeling techniques. This is a method that uses payment data that is summed up with respect to accident time and the time

delay between accident and payment. The data used in this method in the form of a run-off triangle data that is the overall claims data from a summary of the claims of the individual. These claims naturally form an upper left triangle of actual incurred losses and a lower right triangle of future losses which referred to future triangle. Row in the form of run-off triangle stating the time period in which the accident occurred and the column states that the period during the claims settlement. Generally run-off triangle data contain a number of claims or amount claims. The CL method estimates the empty cells of future triangle so the overall claims reserves needed to pay claims will occur in the future can be met.

Several studies conducted to estimate the claim reserve which are Gould (2008) used the model CL stochastic in estimating claim reserve, Weke (2006) which compared the CL method with some other methods of predicting the claim reserve short-term insurance, Weindorfer (2012) which gives a practical guide in using CL method to calculate claims reserves. In addition, Muttaqin et al. (2008) describes some of the problems associated with a data run-off triangle.

The aim of this article is to explain the CL method for estimating claim reserve of one of Indonesia general insurance company in the future time. Data taken are from Statistic and Information Directorate of OJK Indonesia.

2. Literature Study

In the long tail insurance business class, assessment of claims unresolved (outstanding claims liability) are usually based on data in the form of run-off triangle. Run-off triangle data is usually the size of the data claims (claims amount) or it could be a number of claims which are both actually depict the aggregate claim data. In this article, claim amount is used for explaining the CL method. The claim which is described here actually is a summary of an individual claim data (Antonio et al. 2008). Supposed Z_{ij} is a random variable represent the amount of aggregate claim that occurred on period i with $i \epsilon \{1, \ldots, m\}$ paid on delay period j with $j \epsilon \{0, \ldots, m-1\}$, so we have an aggregate claim set aggregate $\{Z_{ij} : i = 1, \ldots, m; j = 0, \ldots, m-1\}$. Table 1 describes incremental data of aggregate claim where a row shows the period of occurrence and column shows the delay period. Data upper left triangle is an observed data and data lower right triangle is future triangle data that is going to be estimated.

As an example, Z_{20} is a claim amount that occurred on period 2 paid in the same period. Z_{21} is a claim amount that happened on the period 2 paid one year later.

Table 1: Run-off triangle data and future triangle in incremental form.

Occurrence Period	Delay Period						
	0	1	2	…	j	…	$m-1$
1	Z_{10}	Z_{11}	Z_{12}	…	Z_{1j}	…	$Z_{1,m-1}$
2	Z_{20}	Z_{21}	Z_{22}	…	Z_{2j}	…	$Z_{2,m-1}$
⋮	⋮	⋮	⋮	⋮	⋰		
i	$Z_{i,0}$	$Z_{i,1}$	$Z_{i,2}$	⋰	Z_{ij}		$Z_{i,m-1}$
⋮	⋮	⋰					
m	$Z_{m,0}$	$Z_{m,1}$	$Z_{m,2}$		$Z_{m,j}$		$Z_{m,m-1}$

To estimate the future claim, CL method uses accumulative claim of Z_{ij}, C_{ij} which is defined by

$$C_{ij} = \sum_{k=0}^{j} Z_{ik},\ i = 1, \dots, m \tag{1}$$

So the form of data into a run-off triangle as in Table 2:

Table 2: Run-off triangle data and future triangle data cumulative form.

Occurrence Period	Delay Period						
	0	1	2	…	j	…	$m-1$
1	C_{10}	C_{11}	C_{12}	…	C_{1j}	…	$C_{1,m-1}$
2	C_{20}	C_{21}	C_{22}	…	C_{2j}	…	$C_{2,m-1}$
⋮	⋮	⋮	⋮	⋮	⋰		
i	$C_{i,0}$	$C_{i,1}$	$C_{i,2}$	⋰	C_{ij}		$C_{i,m-1}$
⋮	⋮	⋰					
m	$C_{m,0}$	$C_{m,1}$	$C_{m,2}$		$C_{m,j}$		$C_{m,m-1}$

Random variable C_{ij} means the cumulative amount of claims for claims occurred in period *i* and paid up with a delay period *j*.

The claim amount is accumulated until delay period *m,* which defined by

$$C_{im} = \sum_{k=0}^{m} Z_{ik} \tag{2}$$

$i = 2, \dots, m$ is referred *ultimate claims* [5].

The CL method is familiar with development factors that are used to predict future claims. The development factor f_j is defined by:

$$\hat{f}_j = \frac{\sum_{i=1}^{m-j} C_{ij}}{\sum_{i=1}^{m-j} C_{i,j-1}}\ j = 1, \dots, m-1 \tag{3}$$

And C_{ij} as defined on (1).

So, if $C_{i0}, C_{i1}, \ldots, C_{i,j-1}$ are given, then the estimator of cumulative claim is:

$$\hat{C}_{ij} = \hat{f}_j C_{i,j-1} \tag{4}$$

for $j = 1, \ldots, m-1$ and $i + j \leq m$ so the expectation of all outstanding claims for period i is

$$E\left[C_{i,m-1}\right] = \left(\prod_{j=m-i+1}^{m-1} f_j\right) C_{i,m-1} \tag{5}$$

for $i = 1, \ldots, m$

The estimator of incremental claim is given by

$$\hat{Z}_{ij} = \hat{C}_{ij} - \hat{C}_{i,j-1} \tag{6}$$

The amount of claim reserve estimation that must be provided by the insurance company until all claim settled $\hat{R}$, is the sum of incremental claim estimator on future triangles:

$$\hat{R} = \sum_{k=m+1}^{m+n} \hat{R}_k,\ n = m-1 \tag{7}$$

And $\hat{R}_k$ as defined in Table 3.

Table 3: The estimator of claim reserve.

Periode	Penduga Cadangan Klaim
m+1	$Z_{m,1}+Z_{m-1,2}+\ldots+Z_{m-n+1,n}$
---	---
m-i+n	$Z_{m,n-i}+Z_{m-1,n-i+1}+\ldots+Z_{m-i,n}$
---	---
m+n	$Z_{m,n}$

3. Data and Methods

The data used are secondary data obtained from the Financial Services Authority (FSA), namely motor vehicle risk profile data PT. Asuransi 'ABC' during the period 2014 consists of insurance claims data as well as coverage data. Risk profile of the motor vehicle data has been arranged in a systematic-field, for example, date of issuance of the policy, the policy code, the number of cars and so on which are recorded on a daily basis. Individual coverage data used to estimate reserves claims is the date of issuance

of the policy, the policy code, number of cars, the price of coverage, the date of the incident, the claim is made, the claim is approved, and then formed into a date agreed incremental data in each period.

Once processed by MS-Excel can be obtained from the data in the form of run-off triangles is a summary of individual data from incremental claims that have been paid in 12 months during 2014. Summary of claims incremental risk profile data motor vehicle PT. Asuransi 'ABC' in the form of run-off triangles can be seen in Table 4:

Table 4: Run-off triangle data of incremental claim amount in PT. Asuransi 'ABC'.

		j											
		0	1	2	3	4	5	6	7	8	9	10	11
i	1	800337	286882	74485	45977	36800	21852	7865	9229	6867	3088	2768	75
	2	350394	123711	108338	63197	44776	20089	8552	7155	9458	4911	3184	
	3	81947	244431	170861	98468	35449	23522	20077	18155	6086	1556		
	4	210860	375077	152288	54469	41559	25229	25800	14880	5477			
	5	153985	423328	139885	95515	50159	40152	11823	8355				
	6	139505	371033	180118	119234	49397	23308	7867					
	7	68862	276910	191102	105339	48892	13867						
	8	185027	475971	241558	88867	28447							
	9	15775	448559	122465	47259								
	10	1185566	291862	93338									
	11	122448	245770										
	12	84887											

Data run-off triangle in Table 4 is the incremental amount of the claim in the period of occurrence i paid in delay j. For example, take the second row and the third column, the amount of the claim number 10838 is the total claims paid from the accumulated incidence in period two were reported up to the third period. In Table 4, there is a vacant lower right triangle that must be estimated. These parts we called as future triangle.

Once the data is in the form of incremental claim is obtained, then the analysis step is performed as follows:

1. Creating a data run-off triangles in the form of cumulative claims
2. Calculating development factor f_j

3. Predicting cumulative claims in future triangles
4. Estimating incremental claim data in future triangles
5. Estimating claim reserves on every delay period
6. Estimating claim reserves on all delay period

In addition to MS Excel in summarizing the individual data, further data processing is done with the help of software R version 3.2.3.

R itself already provides application Chain Ladder.

So the data processing becomes easier.

4. Results and Discussion

Based on the FSA Letter No. 2/SEOJK.05/2013 about Form and Structure of Financial Statements as well as Form and Structure Announcement Summary Financial Statements of Insurance and Reinsurance Company, the general insurance business in Indonesia are grouped in 13 (thirteen) business lines, namely property, motor, cargo, marine hull, aviation, satellite, energy-onshore, energy-offshore, engineering, liability personal accident and health, credit dan surety bond, and others.

PT. Asuransi 'ABC' is one general insurance company in Indonesia which is one of its business lines is motor insurance. In Table 5, we can see the development of premiums and claims during the period 2009 to 2013

Table 5: Claim and premium development in PT. Asuransi 'ABC'. Source: Compiled from FSA Insurance Statistics.

	2009	2010	2011	2012	2013
Premi Bruto	1,923,175.00	2,358,362.00	2,809,831.00	2,560,528.00	3,780,020.00
Klaim Bruto	682,149.00	987,803.00	1,054,262.00	1,252,283.00	1,475,360.00
Klaim Rasio	35%	42%	38%	49%	39%
Premi Netto	1,441,625.00	1,743,532.00	2,009,419.00	2,156,150.00	2,611,551.00
Klaim Netto	632,208.00	807,913.00	952,756.00	1,029,611.00	1,233,695.00
Klaim Rasio	44%	46%	47%	48%	47%

Table 5 shows that the amount of premiums recorded in PT. Asuransi 'ABC' has always been rising each year during 2009 to 2013. Similarly, the number of claims incurred. However, the claim ratio of PT. Asuransi 'ABC' during the period 2009–2013 on average is 41% below the industry average which have claims ratio of 43%. This shows that the company still has a pretty good advantage in running their business.

The period of settlement of claims in motor vehicle insurance business line PT. Asuransi 'ABC' are mostly still more than 1 month of completion. In 2014 for example, the settlement of claims of more than 1 month is 84%, far less than 16% can be completed for less than 1 month.

Data run-off triangle in Table 4 is the incremental amount of the claim in the incidence *i* paid in delay *j*. The data in Table 4 is formed into a cumulative claim as shown in Table 6:

Table 6: Run-off triangle data of cumulative claims.

		j											
		0	1	2	3	4	5	6	7	8	9	10	11
i	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				
	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					
	7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
	8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]							
	9	[illegible]	[illegible]	[illegible]	[illegible]								
	10	[illegible]	[illegible]	[illegible]									
	11	[illegible]	[illegible]										
	12	[illegible]											

Table 6 shows the accumulation of claims incurred in the period i and have been paid up until period j. For claims incurred in the first period the total payment up to 12 months amounted to 127553. While the claims that occurred in the second period, payment made up to 11 periods. The 12^{th} payment has not been performed and should be estimated. Claims incurred in the third period, all payments until the 10 periods, the 11 and 12 payments should be estimated. And so on, until the empty triangle area to the right under the so-called future triangle can be estimated.

Figure 1 illustrates the development of the accumulated payment of any claim for any incidence of claim. Each plot drawings describes the incident began in the first to the last period, so there are 12 plots. It is seen that the incidence in the first period have the most complete data, all payment has been completed, while events that occurred in the months two up to 12 not all payment claims have been settled.

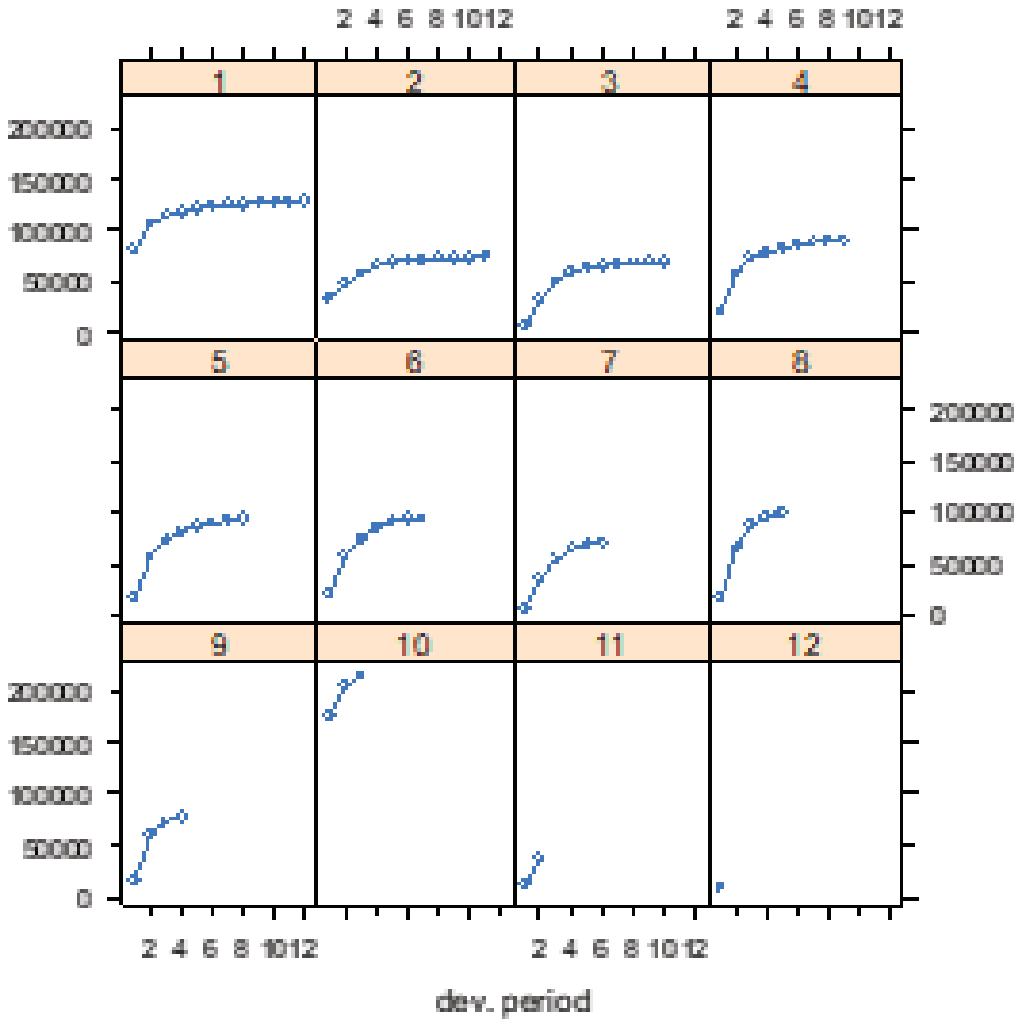

Figure 1: The development of the accumulated payment of any claim for any incidence of claims.

The magnitude estimator of development factor $\hat{f}$ for any period of delay in Table 7.

Table 7: Development Factor $\hat{f}$.

f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11
V1-V2	V2-V3	V3-V4	V4-V5	V5-V6	V6-V7	V7-V8	V8-V9	V9-V10	V10-V11	V11-V12
1.870183	1.203590	1.108037	1.051530	1.028610	1.017082	1.012955	1.007748	1.003852	1.003288	1.000588

The development factor actually is the ratio of accumulated claims paid during the period of delay j to the delay period $j-1$ for the same period of occurrence. $V_1 - V_2$ of 1.870183 means that the ratio of the accumulated delays of the period to claim 2 of the period to 1 amounted to 1.870183 for the period from 1 up to 11 events. $V_2 - V_3$

1.203590 means that the ratio of the delay accumulated claims from period 3 to period to 2 is equal to 1.203590 for the period of occurrence 1 up to 10. And so on up to $V_{11} - V_{12}$ of 1.000588 means the ratio of accumulated claims from month 12 to month to 11 amounted to 1.000588 for the period of one incident.

The development factor is required to estimate the amount of accumulated payments on futures triangle. For example, the estimator of accumulated payments in delay period 11 and period of occurrence 2, is

$$\hat{C}_{2,11} = \hat{f}_1 \cdot C_{2,10} = 1.000588 \cdot 74506 = 74549.80953 \approx 74550$$

The estimator of accumulated payments in delay period 10and 11 on period of occurrence 3, $\hat{C}_{3,10}$ $\hat{C}_{3,11}$, are:

$$\hat{C}_{3,10} = \hat{f}_{10} \cdot C_{3,10} = 1.003288 \cdot 70071 = 70301.393448 \approx 70301$$

$$\hat{C}_{3,11} = \hat{f}_{11} \cdot C_{3,11} = 1.000588 \cdot 70301 = 70342.730667 \approx 70343$$

Table 8: Run-off and future triangles accumulation claims.

		0	1	2	3	4	5	6	7	8	9	10	11
	1	80087	106719	114204	1E+05	122381	124533	1E+05	1E+05	126884	127300	127478	127553
	2	35094	47465	58303	64620	69096	71105	71957	72672	73681	74122	74506	74550
	3	8147	32578	49639	59587	63136	65488	67495	69310	69916	70071	70301	70343
	4	21060	58567	73855	79304	83443	85972	88962	90442	90889	91309	91610	91662
	5	15386	57723	71708	81223	86242	90054	91977	92812	93531	93860	94189	94224
I	6	19505	56608	74626	86350	91347	93665	94442	95666	96407	96746	97064	97121
	7	6862	34552	53654	64193	69085	70452	71663	72591	73153	73411	73652	73696
	8	16507	64078	88236	96423	99270	102110	1E+05	1E+05	106025	106289	106748	106811
	9	15715	60574	72819	77548	81544	83877	85318	86423	87093	87400	87687	87739
	10	176656	205718	215056	2E+05	230569	257738	3E+05	3E+05	267620	268562	268446	268604
	11	12248	36818	44314	49101	51631	53109	54021	54721	55145	55339	55521	55554
	12	8487	15872	19104	21168	22258	22885	23289	23590	23773	23857	23935	23949

And now, the estimator of incremental claim is shown on Table 9 with the calculation examples are

$$\hat{Z}_{2,11} = \hat{C}_{2,11} - \hat{C}_{2,10} = 74550 - 74506 = 44$$

$$\hat{Z}_{12,2} = \hat{C}_{12,2} - \hat{C}_{12,11} = 15872 - 8487 = 7385$$

Table 9: Run-off and future triangles incremental claim estimator.

		j											
		0	1	2	3	4	5	6	7	8	9	10	11
	1	80037	26682	7485	4577	3600	2152	765	929	667	306	278	75
	2	35094	12371	10838	6317	4476	2009	852	715	959	491	384	44
	3	8147	24431	17061	9948	3549	2352	2007	1815	606	155	230	42
	4	21060	37507	15288	5449	4139	2529	2990	1480	547	320	301	53
	5	15395	42328	13985	9515	5019	4012	1723	835	719	329	309	55
i	6	19505	37103	18018	11724	4997	2308	787	1224	741	339	318	57
	7	6862	27690	19102	10539	4892	1367	1211	928	562	258	241	44
	8	16507	47571	24158	8187	2847	2840	1755	1345	815	374	349	63
	9	15715	44859	12245	4729	3996	2333	1441	1105	670	307	287	52
	10	2E+05	29162	9338	23234	12279	7169	4428	3397	2057	942	884	158
	11	12248	24570	7496	4787	2530	1478	912	700	424	194	182	33
	12	8487	7385	3232	2064	1090	637	394	301	183	84	78	14

The claim reserves amount on future triangles should be prepared by the insurance company 'ABC' until all claims are settled stated is a summation of all claims on futures triangle, which is

$$44 + 230 + 320 + \cdots + 42 + 301 + \cdots + 33 + 78 + 14 \;=\; 114803$$

Nevertheless, it can also elaborate the claim reserves which should be provided by company for any period which will come to all the occurrences. For example, for the period to 13, the amount of claims reserves is 230 + 44 + 320 +... + 7496 + 7386 = 48699, for the period to 14 is 42 + 301 +... + 4787 + 3232 = 26727. And so on until the period to 23 by 14.

The claim reserves that must be provided by the company for all occurrences up to 23 future periods are shown in Table 10.

From the aforementioned description shows that the chain ladder method can be used to calculate the claims reserve. However, claims reserves generated by this method have not been able to separate the claims reserves into IBNR claims reserves and RBNS claims reserves. In addition, claims reserves estimate is generated only able to predict until a period of $2m - 1$. To estimate the claims reserves beyond this period, we need the other method to approach, for example by a double chain ladder method.

TABLE 10: Claim reserves up to 23 future periods.

Period	Claim Reserves Estimator
13	48609
14	26727
15	15812
16	9547
17	6288
18	3851
19	2017
20	1313
21	424
22	111
23	14

5. Conclusion

An insurance company must set aside enough money to pay all claims that unpredictability occurred. The claim reserve is used to pay out claim that have been reported and are qualified to be paid. The claim payment can be directly paid after reported or sometimes need more time to be paid so there are some delay times come up.

Chain Ladder (CL) method can be used to calculate the claims reserves. The CL method is simple and logical, and is widely used in general insurance and a method that has distribution-free property. Actually, this method is a simple algorithm that uses a run-off triangle data of cumulative claims. Nevertheless, this method has not been able to separate the claims reserves into IBNR claims reserves and RBNS claims reserves. And the estimation has a limitation also which is only can predict the estimation till $2m - 1$ period.

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